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Recommended
Standards
For Water Works

2003 Edition

Policies for the Review and Approval
of Plans and Specifications for Public Water Supplies

A Report of the Water Supply Committee of the
Great Lakes--Upper Mississippi River Board
of State and Provincial Public Health and Environmental Managers

MEMBER STATES AND PROVINCE
Illinois Indiana Iowa Michigan Minnesota Missouri
New York Ohio Ontario Pennsylvania Wisconsin

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FOREWORD

The Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers in 1950 created a Water Supply Committee consisting of one associate from each state represented on the Board. A representative from the Province of Ontario was added in 1978. Throughout this document the term state shall mean a representative state or the Province of Ontario. The Committee was assigned the responsibility for reviewing existing water works practices, policies, and procedures, and reporting its findings to the

Board. The report of the Water Supply Committee was first published in 1953, and subsequently has been revised and published in 1962, 1968, 1976, 1982, 1987, 1992, 1997, and 2003.

This document includes the following:

1. Policy Statements - Preceding the standards are policy statements of the Board concerning water works design, practice, or resource protection. Some policy statements recommend an approach to the investigation of innovative treatment processes which have not been included as part of the standards because sufficient confirmation has not yet been documented to allow the establishment of specific limitations or design parameters. Other policy statements recommend approaches, alternatives or considerations in addressing a specific water supply issue and may not develop into standards.

2. Interim Standards - Following the policy statements are interim standards. The interim standards give design criteria which are currently being used for new treatment processes, but the use of the criteria is limited and insufficient for recognition as a recommended standard.

3. Recommended Standards - The Standards, consisting of proven technology, are intended to serve as a guide in the design and preparation of plans and specifications for public water supply systems, to suggest limiting values for items upon which an evaluation of such plans and specifications may be made by the reviewing authority, and to establish, as far as practicable, uniformity of practice. Because statutory requirements and legal authority pertaining to public water supplies are not uniform among the states, and since conditions and administrative procedures and policies also differ, the use of these standards must be adjusted to these variations.

The terms shall and must are used where practice is sufficiently standardized to permit specific delineation of requirements or where safeguarding of the public health justifies such definite action. Other terms, such as should, recommended, and preferred, indicate desirable procedures or methods, with deviations subject to individual consideration.

Most quantified items in this document are cited in US customary units and are rounded off at two significant figures. Metric equivalent quantities, also rounded off at two significant figures, follow in brackets where compound units are involved. The metric unit symbols follow

International System conventions. In the event of a conflict between quantities in US units and the metric equivalent the quantity in US units shall take precedence.

It is not possible to cover recently developed processes and equipment in a publication of this type. However, the policy is to encourage, rather than obstruct, the development of new processes and equipment. Recent developments may be acceptable to individual states if they meet at least one of the following conditions: 1) have been thoroughly tested in full scale comparable installations under competent supervision, 2) have been thoroughly tested as a pilot plant operated for a sufficient time to indicate satisfactory performance, or 3) a performance bond or other acceptable arrangement has been made so the owners or official custodians are adequately protected financially or otherwise in case of failure of the process or equipment.

The Board recognizes that many states, other than those of the Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers, utilize this publication as part of their design requirements for water works facilities. The Board welcomes this practice as long as credit is given to the Board and to this publication as a source for the standards adopted. Suggestions from non-member states are welcome and will be considered.

Adopted April, 1997

POLICY STATEMENT ON PRE-ENGINEERED WATER TREATMENT PLANTS

Pre-engineered water treatment plants are becoming available and being used for production of potable water at public water systems. Many applications being proposed are for small systems having relatively clean surface water sources which are now being required to provide filtration under the federal Safe Drinking Water Act.

Pre-engineered water treatment plants are normally modular process units which are pre-designed for specific process applications and flow rates and purchased as a package. Multiple units may be installed in parallel to accommodate larger flows.

Pre-engineered treatment plants have numerous applications but are especially applicable at small systems where conventional treatment may not be cost effective. As with any design the proposed treatment must fit the situation and assure a continuous supply of safe drinking water for water consumers. The reviewing authority may accept proposals for pre-engineered water treatment plants on a case by case basis where they have been demonstrated to be effective in treating the source water being used.

Factors to be considered include:

1. Raw water quality characteristics under normal and worst case conditions. Seasonal fluctuations must be evaluated and considered in the design.

2. Demonstration of treatment effectiveness under all raw water conditions and system flow demands. This demonstration may be on-site pilot or full scale testing or testing off-site where the source water is of similar quality. On-site testing is required at sites having questionable water quality or applicability of the treatment process. The proposed demonstration project must be approved by the reviewing authority prior to starting.

3. Sophistication of equipment. The reliability and experience record of the proposed treatment equipment and controls must be evaluated.

4. Unit process flexibility which allows for optimization of treatment.

5. Operational oversight that is necessary. At surface water sources full-time operators are necessary, except where the reviewing authority has approved an automation plan. See Policy Statement on Automated/Unattended Operation of Surface Water Treatment Plants.

6. Third party certification or approvals such as National Sanitation Foundation (NSF) for a) treatment equipment and b) materials that will be in contact with the water.

7. Suitable pretreatment based on raw water quality and the pilot study or other demonstration of treatment effectiveness.

8. Factory testing of controls and process equipment prior to shipment.

9. Automated troubleshooting capability built into the control system.

10. Start-up and follow-up training and troubleshooting to be provided by the manufacturer or contractor.

11. Operation and maintenance manual. This manual must provide a description of the treatment, control and pumping equipment, necessary maintenance and schedule, and a troubleshooting guide for typical problems.

12. On-site and contractual laboratory capability. The on-site testing must include all required continuous and daily testing as specified by the reviewing authority. Contract testing may be considered for other parameters.

13. Manufacturers warranty and replacement guarantee. Appropriate safeguards for the water supplier must be included in contract documents. The reviewing authority may consider interim or conditional project approvals for innovative technology where there is sufficient demonstration of treatment effectiveness and contract provisions to protect the water supplier should the treatment not perform as claimed.

14. Water supplier revenue and budget for continuing operations, maintenance and equipment replacement in the future.

Additional information on this topic is given in the State Alternative Technology Approval Protocol dated June, 1996 which was developed by the Association of State Drinking Water Administrators, U.S. Environmental Protection Agency and various industry groups.

Adopted April, 1997

POLICY STATEMENT ON CONTROL OF ORGANIC CONTAMINATION FOR PUBLIC WATER SUPPLIES

Although standards and advisories for organics are being developed, there have been numerous cases of organic contamination of public water supply sources. In all cases, public exposure to organic contamination must be minimized. There is insufficient experience to establish design standards which would apply to all situations. Controlling organic contamination is an area of design that requires pilot studies and early consultation with the reviewing authority. Where treatment is proposed, best available technology shall be provided to reduce organic contaminants to the lowest practical levels. Operations and monitoring must also be considered in selecting the best alternative. The following alternatives may be applicable:

1. Alternate Source Development

2. Existing Treatment Modifications

3. Air Stripping For Volatile Organics (See 4.5.4 Packed Tower Aeration)

4. Granular Activated Carbon

Consideration should be given to:

a. using contact units rather than replacing a portion of existing filter media;

b. series and parallel flow piping configurations to minimize the effect of breakthrough without reliance on continuous monitoring;

c. providing at least two units. Where only two units are provided, each shall be capable of meeting the plant design capacity (normally the projected maximum daily demand) at the approved rate. Where more than two units are provided, the contactors shall be capable of meeting the design capacity at the approved rate with one or more (as determined in conjunction with the reviewing authority) units removed from service;

d. using virgin carbon; this is the preferred media. Although reactivated carbon may eventually present an economic advantage at large water treatment plants, such an alternative may be pursued only with the preliminary endorsement of the reviewing authority. Regenerated carbon using only carbon previously used for potable water treatment can be used for this purpose. Transportation and regeneration facilities must not have been used for carbon put to any other use;

e. acceptable means of spent carbon disposal.

Except for temporary, emergency treatment conditions, particular attention should be given to developing an engineering report which, in addition to the normal determinations, includes the following:

1. For organic contaminants found in surface water sources:

a. type of organic chemicals, sources, concentration, frequency of occurrence, water pollution abatement schedule, etc.,

b. possible existing treatment plant modifications to lower organic chemical levels. Results of bench, pilot or full scale testing demonstrating treatment alternatives, effectiveness and costs,

c. a determination of the quality and/or operational parameters which serve as the best measurement of treatment performance, and a corresponding monitoring and process control program.

2. For organic contamination found in groundwater sources:

a. types of organic chemicals, sources, concentration, estimate of residence time within the aquifer, plume delineation, flow characteristics, water pollution abatement schedule, etc.,

b. results of bench or pilot studies demonstrating treatment alternatives, effectiveness, and costs,

c. a determination of the quality and/or operational parameters which serve as the best measure of treatment performance, and a corresponding monitoring and process control program,

d. development and implementation of a wellhead protection plan.

The collection of this type of data is often complicated and lengthy. Permanent engineering solutions will take significant time to develop. The cost of organic analyses and the availability of acceptable laboratories may further complicate both pilot work and actual operation.

Alternative source development or purchase of water from nearby unaffected systems may be a more expedient solution for contaminated groundwater sources.

Adopted April, 1987
Revised April, 1991
Revised April, 1997

POLICY STATEMENT ON INTERNAL CORROSION CONTROL FOR PUBLIC WATER SUPPLIES

Internal and external corrosion of a public water supply distribution system is a recognized problem that cannot be completely eliminated but can be effectively controlled. Aside from the economic and aesthetic problems, the possible adverse health effects of corrosion products, such as lead and copper, is a major consideration. See section 8.5.7 for external corrosion control.

Corrosion of metallic pipes is a chemical oxidation process which requires that both water and an oxidizing agent be present at metal surfaces. The process is driven by the energy released when atoms from the metal surface are converted into hydrated metal cations. The three main factors which can accelerate corrosion are:
a) failure of the water chemistry to provide a coherent protecting film of corrosion products on the metal surface,
b) increased biofilm activity as a result of loss of the regular controlling disinfectant residual, and
c) direct electrical contact between different metals in the presence of high conductance water.

Control of corrosion is a function of the design, maintenance, and operation of a public water supply. These functions must be considered simultaneously in order for the corrosion control program to function properly. Corrosion problems must be solved on an individual basis depending on the specific water quality characteristics and materials used in the distribution system. Specific information can be obtained from publications of technical agencies and associations such as USEPA (*Corrosion Manual for Internal Corrosion of Water Distribution Systems*, 1984; *Control of Lead and Copper in Drinking Water*, 1993; *Lead and Copper Regulations*, 1994) and the American Water Works Association (*Lead and Copper Strategies*, 1990; *Chemistry of Corrosion Inhibitors in Potable Waters*, 1990; *Internal Corrosion of Water Distribution Systems, 2nd edition*, 1996) Broad areas of consideration for a corrosion control program follow.

Internal Corrosion

1. Provide for a system of records by which the nature and frequency of corrosion problems are recorded. On a plat map of the distribution system, show the location of each problem so that follow-up investigations and improvements can be made when a cluster of problems is identified.

2. When complaints are received from a customer, follow up with an inspection by experienced personnel or consultant experienced in corrosion control. Where advisable, obtain samples of water using appropriate sampling protocols for chemical and microbiological analyses and piping and plumbing material samples. Analyses should be made to determine the type and, if possible, the cause of the corrosion.

3. Establish a program or conduct desktop analyses or pipe loop studies to determine the corrosiveness of the water in representative parts of the distribution system. Analysis for alkalinity, pH, temperature, calcium, specific conductance or total dissolved solids, chlorides, sulfates and corrosion products (such as lead, cadmium, copper, zinc and iron) should be performed on water samples collected at the treatment plant or wellhead and at representative points on the distribution system including first draw samples taken after the water had sat overnight at locations where lead- soldered copper internal plumbing is in use. By comparing the analyses of the source water with the distribution system water, significant changes in alkalinity, pH, or corrosion products would indicate that corrosion may be taking place and thereby indicate that corrective steps may need to be taken.

4. Where possible, especially when corrosion has been detected provide a program that will measure both the physical and chemical aspects of the corrosion phenomena. Physical measurement of the rate of corrosion can be made by the use of coupons, easily removed sections of pipe, connected flow-through pipe test sections or other piping arrangements. At the same site, estimate the relative degree of corrosivity on a routine basis by using desktop analyses or corrosion indices such as the Langelier Index, Ryznar Index, calcium carbonate precipitation potential or Aggressiveness Index (AWWA C-400). Correlation of the data from the physical measurement with the data from the selected corrosion analysis may provide information to determine the type of corrective treatment needed (though the different indices may not always agree) and may allow for the subsequent use of the corrosion analysis alone to determine the degree of corrosivity in select areas of the distribution system.

5. If corrosion is found to exist throughout the distribution system, corrective measures at the treatment plant, pump station or well head should be initiated. A chemical feed can be made to provide a stable to slightly depositing water or water quality which mitigates the solubility of targeted parameters. In calculating the stability index and the corresponding chemical feed adjustments,

consideration must be given to items such as the water temperature, if it varies with the season and within various parts of the distribution system; the velocity of flow within various parts of the distribution system; the degree of stability needed by the individual customer; and the dissolved oxygen content of distributed water, especially in waters having low hardness and alkalinity. Threshold treatment involving the feeding of a ortho- or blended phosphate or a silicate to control corrosion may be considered for both ground and surface water supplies.

6. Additional control of corrosion problems can be obtained by a regulation or ordinance for the materials used in or connected to a distribution system. Careful selection of materials compatible with the physical system or the water being delivered can aid in reduction of corrosion product production.

Note: Adjustment of pH for corrosion control *must not* interfere with other pH dependent processes (e.g., color removal by alum coagulation) or aggravate other water quality parameters (e.g., THM formation). In addition, the use of ortho- or blended phosphates should not aggravate distribution microbial concerns or adversely impact wastewater facilities.

Adopted April, 1982
Revised April, 1997
Revised April, 2003

POLICY STATEMENT ON TRIHALOMETHANE REMOVAL AND CONTROL FOR PUBLIC WATER SUPPLIES

Trihalomethanes (THMs) are formed when free chlorine reacts with organic substances, most of which occur naturally. These organic substances (called "precursors"), are a complex and variable mixture of compounds. Formation of THMs is dependent on such factors as amount and type of chlorine used, temperature, concentration of precursors, pH, and contact time. Approaches for controlling THMs include:

1. Control of precursors at the source.

a. Selective withdrawal from reservoirs -- varying depths may contain lower concentrations of precursors at different times of the year.

b. Plankton Control -- Algae and their by-products have been shown to act as THM precursors.

c. Alternative sources of water may be considered, where available.

2. Removal of THM precursors and control of THM formation.

a. Moving the point of chlorination to minimize THM formation.

b. Removal of precursors prior to chlorination by optimizing:

(1) Coagulation/flocculation -- sedimentation -- filtration

(2) Precipitative softening/filtration

(3) Direct filtration

c. Adding oxidizing agents such as potassium permanganate, ozone or chlorine dioxide to reduce or control THM formation potential.

d. Adsorption by powdered activated carbon (PAC).

e. Lowering the pH to inhibit the reaction rate of chlorine with precursor materials. Corrosion control may be necessary.

3. Removal of THM.

a. Aeration -- by air stripping towers.

b. Adsorption by:

(1) Granular Activated Carbon (GAC)

(2) Synthetic Resins

4. Use of Alternative Disinfectants -- Disinfectants that react less with THM precursors may be used as long as microbiological quality of the finished water is maintained. Alternative disinfectants may be less effective than free chlorine, particularly with viruses and parasites. Alternative disinfectants, when used, must be

capable of providing an adequate distribution system residual. Possible health effects of by-products that may be produced by using alternative disinfectants must be taken into consideration. The following alternative disinfectants may be used:

a. Chlorine Dioxide

b. Chloramines

c. Ozone

Using various combinations of THM controls and removal techniques may be more effective than a single control or a treatment method.

Any modifications to existing treatment process must be approved by the reviewing authority. Pilot plant studies are desirable.

Adopted April, 1987
Revised April, 1997

POLICY STATEMENT ON REVERSE OSMOSIS AND NANOFILTRATION FOR PUBLIC WATER SUPPLIES

Reverse osmosis (RO) is a physical process in which a suitably pretreated water is delivered at moderate pressures against a semipermeable membrane. The membrane rejects most solute ions and molecules, while allowing water of very low mineral content to pass through. The process produces a concentrated waste stream in addition to the clear permeate product. Reverse osmosis systems have been successfully applied to saline ground waters, brackish waters, and seawater, as well as for inorganic contaminants such as radionuclides, nitrates, arsenic, etc. and other contaminants such as pesticides, viruses, bacteria and protozoa. A lower pressure RO called nanofiltration (NF), also known as membrane softening, has been successfully utilized for hard, high color and high organic content feed waters. NF has a lower monovalent ion rejection, making it more attractive to water with low salinity, thereby reducing post treatment and conditioning as compared to RO.

The following items should be considered in evaluating the applicability for reverse osmosis and nanofiltration:

1. Membrane Selection: Two types of membranes are typically used. These are cellulose acetate based and polyamide composites. Membrane configurations typically include tubular, spiral wound and hollow fiber. Operational conditions and useful life vary depending on type of membrane selected, quality of feed water, and process operating parameters.

2. Useful Life of the Membrane: The membrane replacement represents a major cost component in the overall water production costs. Membrane replacement frequency can significantly affect the overall cost of operating the treatment facility. Power consumption may also be a significant cost factor for RO plants.

3. Pretreatment Requirements: Acceptable feedwater characteristics are dependent on the type of membrane and operational parameters of the system. Without suitable pretreatment or acceptable feed water quality, the membrane may become fouled or scaled and consequently shorten its useful life. Pretreatment is usually needed for turbidity reduction, iron or manganese removal, stabilization of the water to prevent scale formation, microbial control, chlorine removal (for certain membrane types), and pH adjustment. Usually, at a minimum, cartridge filters should be provided for the protection of the membranes against particulate matter.

4. Treatment Efficiency: RO is highly efficient in removing metallic salts and ions from the raw water. Efficiencies, however, do vary depending on the ion being removed and the membrane utilized. For most commonly encountered ions, removal efficiencies will range from 85% to over 99%. Organics removal is dependent on the molecular weight, shape and charge of the organic molecule and the pore size of the membrane utilized. Removal efficiencies may range from as high as 99% to less than 30%, depending on the membrane type and treatment objective.

5. Bypass Water: RO permeate will be virtually demineralized. NF permeate may also contain less dissolved minerals than desirable. The design should provide for a portion of the raw water to bypass the unit to maintain a stable water within the distribution system and to improve process economics as long as the raw water does not contain unacceptable contaminants. Alternative filtration is required for bypassed surface water or ground water under the direct influence of surface water.

6. Post Treatment: Post treatment typically includes degasification for carbon dioxide (if excessive) and hydrogen sulfide removal (if

present), pH and hardness adjustment for corrosion control and disinfection as a secondary pathogen control and for distribution system protection.

7. Reject Water: Reject water may range from 10% to 50% of the raw water pumped to the reverse osmosis unit. For most brackish waters and ionic contaminant removal applications, reject is in the 10-25% range while for seawater it could be as high as 50%. The reject volume should be evaluated in terms of the source availability and from the waste treatment availabilities. The amount of reject water from a unit may be reduced to a limited extent by increasing the feed pressure to the unit. However, this may result in a shorter membrane life. Acceptable methods of waste disposal typically include discharge to a municipal sewer system, to waste treatment facilities, or to an evaporation pond.

8. Cleaning the Membrane: The membrane must be periodically cleaned with acid, detergents and possibly disinfection. Method of cleaning and chemicals used must be approved by the state reviewing agency. Care must be taken in the cleaning process to prevent contamination of both the raw and finished water system. Cleaning chemicals, frequency and procedure should follow membrane manufacturer's guidelines.

9. Pilot Plant Study: Prior to initiating the design of a membrane treatment facility, the state reviewing agency should be contacted to determine if a pilot plant study will be required. In most cases, a pilot plant study will be required to determine the best membrane to use, the type of pretreatment, type of post treatment, the bypass ratio, the amount of reject water, system recovery, process efficiency and other design and operational criteria.

10. Operator training and startup: The ability to obtain qualified operators must be evaluated in selection of the treatment process. The necessary operator training shall be provided prior to plant startup.

Adopted April, 1991
Revised April, 2003

POLICY STATEMENT ON AUTOMATED/UNATTENDED OPERATION OF SURFACE WATER TREATMENT PLANTS

Recent advances in computer technology, equipment controls and Supervisory Control and Data Acquisition (SCADA) Systems have brought automated and off-site operation of surface water treatment plants into the realm of feasibility. Coincidentally, this comes at a time when renewed concern for microbiological contamination is driving optimization of surface water treatment plant facilities and operations and finished water treatment goals are being lowered to levels of <0.1 NTU turbidity and <20 total particle counts per milliliter.

Review authorities encourage any measures, including automation, which assist operators in improving plant operations and surveillance functions.

Automation of surface water treatment facilities to allow unattended operation and off-site control presents a number of management and technological challenges which must be overcome before an approval can be considered. Each facet of the plant facilities and operations must be fully evaluated to determine what on-line monitoring is appropriate, what alarm capabilities must be incorporated into the design and what staffing is necessary. Consideration must be given to the consequences and operational response to treatment challenges, equipment failure and loss of communications or power.

An engineering report shall be developed as the first step in the process leading to design of the automation system. The engineering report to be submitted to review authorities must cover all aspects of the treatment plant and automation system including the following information/criteria:

1. Identify all critical features in the pumping and treatment facilities that will be electronically monitored, have alarms and can be operated automatically or off-site via the control system. Include a description of automatic plant shut-down controls with alarms and conditions which would trigger shut-downs. Dual or secondary alarms may be necessary for certain critical functions.

2. Automated monitoring of all critical functions with major and minor alarm features must be provided. Automated plant shutdown is required on all major alarms. Automated startup of the plant is prohibited after shutdown due to a major alarm. The control system must have response and adjustment capability on all minor alarms. Built-in control system challenge test capability must be provided to verify operational status of major and minor alarms.

3. The plant control system must have the capability for manual operation of all treatment plant equipment and process functions.

4. A plant flow diagram which shows the location of all critical features, alarms and automated controls to be provided.

5. Description of off-site control station(s) that allow observation of plant operations, receiving alarms and having the ability to adjust and control operation of equipment and the treatment process.

6. A certified operator must be on "standby duty" status at all times with remote operational capability and located within a reasonable response time of the treatment plant.

7. A certified operator must do an on-site check at least once per day to verify proper operation and plant security.

8. Description of operator staffing and training planned or completed in both process control and the automation system.

9. Operations manual which gives operators step by step procedures for understanding and using the automated control system under all water quality conditions. Emergency operations during power or communications failures or other emergencies must be included.

10. A plan for a 6 month or more demonstration period to prove the reliability of procedures, equipment and surveillance system. A certified operator must be on-duty during the demonstration period. The final plan must identify and address any problems and alarms that occurred during the demonstration period. Challenge testing of each critical component of the overall system must be included as part of the demonstration project.

11. Schedule for maintenance of equipment and critical parts replacement.

12. Sufficient finished water storage shall be provided to meet system demands and CT requirements whenever normal treatment production is interrupted as the result of automation system failure or plant shutdown.

13. Sufficient staffing must be provided to carry out daily on-site evaluations, operational functions and needed maintenance and calibration of all critical treatment components and monitoring equipment to ensure reliability of operations.

14. Plant staff must perform as a minimum weekly checks on the communication and control system to ensure reliability of

operations. Challenge testing of such equipment should be part of normal maintenance routines.

15. Provisions must be made to ensure security of the treatment facilities at all times. Incorporation of appropriate intrusion alarms must be provided which are effectively communicated to the operator in charge.

Adopted April, 1997

POLICY STATEMENT ON BAG AND CARTRIDGE FILTERS FOR PUBLIC WATER SUPPLIES

Bag and cartridge technology has been used for some time in the food, pharmaceutical and industrial applications. This technology is increasingly being used by small public water supplies for treatment of drinking water. A number of states have accepted bag and cartridge technology as an alternate technology for compliance with the filtration requirements of the Surface Water Treatment Rule.

The particulate loading capacity of these filters is low, and once expended the bag or cartridge filter must be discarded. This technology is designed to meet the low flow requirement needs of small systems. The operational and maintenance cost of bag and cartridge replacement must be considered when designing a system. These filters can effectively remove particles from water in the size range of Giardia cysts (5-10 microns) and Cryptosporidium (2-5 microns).

At the present time, filtration evaluation is based on Giardia cyst removal. However, consideration should be given to the bag or cartridge filters ability to remove particles in the size range of Cryptosporidium since this is a current public health concern.

With this type of treatment there is no alteration of water chemistry. So, once the technology has demonstrated the required removal efficiency, no further pilot demonstration may be necessary. The demonstration of filtration is specific to a specific housing and a specific bag or cartridge filter. Any other combinations of different bags, cartridges, or housings will require additional demonstration of filter efficiency.

Treatment of a surface water should include source water protection, filtration, and disinfection.

The following items should be considered in evaluating the applicability of bag or cartridge filtration.

Predesign/Design

1. The filter housing and bag/cartridge filter must demonstrate a filter efficiency of at least 2-log reduction in particles size 2 micron and above. Demonstration of higher log removals may be required by the reviewing authority depending on raw water quality and other treatment steps to be employed. The reviewing authority will decide whether or not a pilot demonstration is necessary for each installation. This filtration efficiency may be accomplished by:

    a. Microscopic particulate analysis, including particle counting, sizing and identification, which determines occurrence and removals of micro-organisms and other particle across a filter or system under ambient raw water source condition, or when artificially challenged.

    b. Giardia/Cryptosporidium surrogate particle removal evaluation in accordance with procedures specified in NSF Standard 53 or equivalent. These evaluations can be conducted by NSF or by another third-party whose certification would be acceptable to the reviewing authority.

    c. "Particle Size Analysis Demonstration for Giardia Cyst Removal Credit" procedure presented in Appendix M of the EPA Surface Water Treatment Rule Guidance Manual.

    d. "Nonconsensus" live Giardia challenge studies that have been designed and carried out by a third-party agent recognized and accepted by the reviewing authority for interim evaluations. At the present time uniform protocol procedures for live Giardia challenge studies have not been established. If a live Giardia challenge study is performed on site there must be proper cross- connection control equipment in place and the test portion must be operated to waste.

    e. Methods other than these that are approved by the reviewing authority.

    f. System components such as housing, bags, cartridges, membranes, gaskets, and O-rings should be evaluated under NSF Standard 61 or equivalent, for leaching of contaminants. Additional testing may be required by the reviewing authority.

2. The source water or pre-treated water should have a turbidity less than 5 NTU.

3. The flow rate through the treatment process shall be monitored with a flow valve and meter. The flow rate through the bag/cartridge filter must not exceed 20 gpm, unless documentation at higher flow rates demonstrates that it will meet the requirements for removal of particles.

4. Pretreatment is strongly recommended (if not required by the reviewing authority). This is to provide a more constant water quality to the bag/cartridge filter and to extend bag and cartridge life. Examples of pretreatment include media filters, larger opening bag/cartridge filters, infiltration galleries, and beach wells. Location of the water intake should be considered in the pretreatment evaluation.

5. Particle count analysis can be used to determine what level of pretreatment should be provided. It should be noted that particulate counting is a 'snap shot' in time and that there can be seasonal variations such as algae blooms, lake turnover, spring runoff, and heavy rainfall events that will give varied water quality.

6. It is recommended that chlorine or another disinfectant be added at the head of the treatment process to reduce/eliminate the growth of algae, bacteria, etc., on the filters. The impact on disinfection-by-product formation should be considered.

7. A filter to waste component is strongly recommended (if not required by the reviewing authority), for any pretreatment pressure sand filters. At the beginning of each filter cycle and/or after every backwash of the prefilters a set amount of water should be discharged to waste before water flows into the bag/cartridge filter. Filter to waste shall be provided for the final filter(s) and a set amount of water shall be discharged to waste after changing the filters.

8. If pressure media filters are used for pretreatment they must be designed according to Section 4.2.2.

9. A sampling tap shall be provided ahead of any treatment so a source water sample can be collected.

10. Pressure gages and sampling taps shall be installed before and after the media filter and before and after the bag/cartridge filter.

11. An automatic air release valve shall be installed on top of the filter housing.

12. Frequent start and stop operation of the bag or cartridge filter should be avoided. To avoid this frequent start and stop cycle the following options are recommended:

   a. a slow opening and closing valve ahead of the filter to reduce flow surges.

   b. reduce the flow through bag or cartridge filter to as low as possible to lengthen filter run times.

   c. install a recirculating pump that pumps treated water back to a point ahead of the bag or cartridge filter. Care must be taken to make sure there is no cross connection between the finished water and raw water.

13. A minimum of two bag or cartridge filter housings should be provided for water systems that must provide water continuously.

14. A pressure relief valve should be incorporated into the bag or cartridge filter housing.

15. Complete automation of the treatment system is not required. Automation of the treatment plant should be incorporated into the ability of the water system to monitor the finished water quality. It is important that a qualified water operator is available to run the treatment plant.

16. A plan of action should be in place should the water quality parameters fail to meet EPA or the local reviewing authorities standards.

Operations

1. The filtration and backwash rates shall be monitored so that the prefilters are being optimally used.

2. The bag and cartridge filters must be replaced when a pressure difference of 30 psi or other pressure difference recommended by the manufacturer is observed. It should be noted that bag filters do not load linearly. Additional observation of the filter performance is required near the end of the filter run.

3. Maintenance (o-ring replacement) shall be performed in accordance with the manufacturers recommendations.

4. Sterile rubber gloves and a disposable face mask covering the nose and mouth shall be worn when replacing or cleaning the cartridge or bag filters.

5. The filter system shall be properly disinfected and water shall be ran to waste each time the cartridge or bag filter vessels are opened for maintenance.

6. The following parameters should be monitored:

Flow rate, instantaneous

Flow rate, total

Operating pressure

Pressure differential

Turbidity

Adopted April, 1997
Revised April, 2003

POLICY STATEMENT ON CONTROL OF ZEBRA MUSSELS FOR PUBLIC WATER SUPPLIES

The zebra mussel (Dreissena polymorpha) is a freshwater bivalve that was believed to have been accidentally introduced into the Great Lakes ecosystem around 1986. The zebra mussel has the potential to biofoul public water supply intake facilities and cause loss of intake capacity as well as contribute to taste and odor problems. The zebra mussel has spread rapidly throughout the Great Lakes and Mississippi River Basins and could potentially affect surface water supplies throughout the country.

The zebra mussel breeds prolifically in waters with temperatures between 45-52 degrees Fahrenheit with the larval, or veliger, stage being highly mobile in water currents. The post veligers settle out and attach themselves to a hard substrate (such as an intake structure) where they become adults; reaching sizes up to two inches. Many common construction materials can serve as substrates on which the mussels can build onto themselves and form deep layers within a few seasons.

Water suppliers should periodically assess the condition of their intakes to determine if zebra mussel veligers or adults are or potentially may be present and implement a system of control. Physical controls typically include removal of adults by mechanical scraping (pigging) and hydroblasting; whereas chemical treatment has proven to be most effective for short and long term control and elimination.

The most accepted and currently recommended forms of chemical treatment for public water supplies are the use of oxidants such as chlorine, chlorine dioxide, potassium permanganate and ozone. Various approved molluscicides have also been used. Chemical dosages are typically applied at the intake through solution piping and a diffuser to prevent the formation of zebra mussel colonies within the intake and piping. The type of chemical selected and frequency of application will depend on the type of existing chemical treatment facilities, zebra mussel breeding season, potential for THM formation, other pretreatment objectives such as taste and odor control, safety and economy.

The following items should be addressed in the design:

1. Chemical treatment design shall be in accordance with applicable sections of Recommended Standards For Water Works and shall be acceptable to the reviewing authority.

2. Plant safety items, including but not limited to ventilation, operator protective equipment, eyewashes/showers, cross connection control, etc., shall be provided.

3. Solution piping and diffusers shall be positively anchored. Piping shall have appropriate valving and shall be preferably installed within the intake pipe or in a suitable carrier pipe. Provisions shall be made to prevent dispersal of chemical into the water environment outside the intake. Diffusers shall be located and designed to protect all intake structure components.

4. Consideration shall be given to providing a spare solution line to provide redundancy and to facilitate the use of alternate chemicals.

5. Chemical feeders shall be interlocked with plant system controls to shut down automatically when raw water flows stop.

6. Provisions for obtaining raw water samples not influenced by chemical treatment.

7. When alternative control methods are proposed, for example, sonic energy, non-adhering surfaces or infiltration galleries, appropriate piloting or demonstration studies, satisfactory to the reviewing authority, should be considered.

All designs of zebra mussel control systems shall be submitted to and receive the approval of the reviewing authority prior to installation.

Adopted April 1997

POLICY STATEMENT ON MICROFILTRATION AND ULTRAFILTRATION FOR PUBLIC WATER SUPPLIES

Low pressure membrane filtration technology has emerged as a viable option for addressing current and future drinking water regulations related to treatment of surface water sources and groundwater under the direct influence of surface water sources. Recent research and applied full scale facilities have demonstrated the efficient performance of both Microfiltration (MF) and Ultrafiltration (UF) as feasible treatment alternatives to traditional granular media processes. Both MF and UF have been shown to be effective in removing identified parameters of the Surface Water Treatment Rule, such as: giardia, cryptosporidium, bacteria, turbidity and possibly viruses (for UF). The following provides a brief description and characteristics of each process as well as general selection and design considerations.

Characteristics: MF and UF membranes are most commonly made from organic polymers such as: cellulose acetate, polysulfones, polyamides, polypropylene, polycarbonates and polyvinylidene fluoride (PVDF). The physical configurations include hollow-fiber, spiral wound and tubular. MF membranes are capable of removing particles with sizes down to 0.1-0.2 microns. UF processes have a lower cutoff rating of .005-.01 microns.

Typical flux (rate of finished water permeate per unit membrane surface area) at 20 degrees C for MF ranges between 50-100 gallons/sq.ft./day (gsfd) whereas the typical UF flux range is 10-50 gsfd. Required operating pressures ranges from 5-10 psi for MF and 7-50 psi for UF.

Since both processes have relatively small membrane pore sizes, membrane fouling, caused by organic and inorganic compounds as well as physical contaminants, can occur if the system is not properly selected or operated. Automated periodic back flushing and cleaning is employed on a timed basis or once a targeted transmembrane pressure differential has been reached. Some systems utilize air/water back flush. Typical cleaning agents utilized include acids, bases, complexing agents, surfactants, enzymes and certain oxidants, depending upon membrane material and foulants encountered. Chemicals used for cleaning and the method and procedure of cleaning process must be acceptable to the membrane manufacturer and approved by the reviewing authority.

Overall treatment requirements and disinfection credits must be discussed with and approved by the reviewing authority. Disinfection is required with membrane filtration for additional pathogen control and distribution system protection.

Selection and Design Considerations:

1. A review of historical source raw water quality data, including turbidity and/or particle counts, seasonal changes, organic loading, microbial activity, and temperature differentials as well as other inorganic and physical parameters should be conducted. The data should be used to determine feasibility and cost of the system. The degree of pre-treatment may also be ascertained from the data. Design considerations and membrane selection at this phase must also address the issue of target removal efficiencies and system recovery versus acceptable transmembrane pressure differentials. On surface water supplies, pre-screening or cartridge filters may be required.

2. Prior to initiating the design of a MF or UF treatment facility, the state reviewing authority should be contacted to determine if a pilot plant study will be required. In most cases, a pilot plant study will be necessary to determine the best membrane to use, particulate/organism removal efficiencies, cold and warm water flux, the need for pretreatment, fouling potential, operating and transmembrane pressure and other design and monitoring considerations. Any virus removal credit must also be documented through an appropriate piloting process. The state reviewing authority should be contacted prior to conducting the pilot study to establish the protocol to be followed.

3. The life expectancy of a particular membrane under consideration should be evaluated during the pilot study or from

other relevant available data. Membrane replacement frequency is a significant factor in operation and maintenance cost comparisons in the selection of the process.

4. Some membrane materials are incompatible with certain oxidants. If the system must rely on pre-treatment oxidants for other purposes, for example, zebra mussel control, taste and odor control, or iron and manganese oxidation, the selection of the membrane material becomes a significant design consideration.

5. The source water temperature can significantly impact the flux of the membrane under consideration. At low water temperatures, the flux can be reduced appreciably (due to higher water viscosity and resistance of the membrane to permeate), possibly impacting process economics by the number of membrane units required for a full scale facility. Seasonal variation of design flow rates may be based on documented lower demand during colder weather.

6. Back flushing volumes can range from 5-15 percent of the permeate flow depending upon the frequency of flushing/cleaning and the degree of fouling and this should be considered in the treatment system sizing and the capacity of the raw water source.

7. An appropriate level of finished water monitoring as well as periodic integrity testing shall be provided to routinely evaluate membrane and housing integrity and overall filtration performance. Monitoring options may include particle counters, manual and/or automated pressure testing, air diffusion tests, sonic testing, and biological testing. Consult the appropriate regulatory agency regarding process monitoring requirements.

8. Cross connection control considerations must be incorporated into the system design, particularly with regard to chemical feeds and waste piping used for membrane cleaning, waste stream and concentrate.

9. Redundancy of critical control components including but not limited to valves, air supply, and computers shall be required as per the reviewing authority.

10. Other pre- and post-membrane treatment requirements must be evaluated in the final design to address other contaminants of concern such as color and disinfection by-product precursors.

Adopted April, 1997
Revised April, 2003

POLICY STATEMENT ON ULTRA VIOLET LIGHT FOR TREATMENT OF PUBLIC WATER SUPPLIES

Ultra Violet (UV) Light treatment devices may be used to treat bacteriologically unsafe groundwater from drinking water wells. However, reviewing authorities expect water system owners to take all steps possible to obtain a naturally safe water source before considering treatment. A naturally safe water source provides the best long-term public health protection and there is no reliance on a treatment device to assure safe water. There must be a determination that the bacteriologically unsafe water is not due to the influence of surface water.

Recent research has demonstrated the effectiveness of UV as a primary disinfectant. While this policy statement does not specifically cover UV treatment for surface water or groundwater under the direct influence of surface water, it is not the intent of this policy to discourage such use. Portions of this policy are applicable to the treatment of effectively filtered surface water. The reviewing authority shall be contacted regarding use of UV treatment for these applications.

When a naturally safe groundwater source is not available, or the system owner wishes to provide UV treatment for other reasons, the following criteria shall be considered. Supplemental disinfection to provide a residual in the water distribution system may be required by the approval authority. When UV light treatment devices are used for non-health related purposes the UV device may provide doses less than indicated in the following criteria.

A. CRITERIA FOR UV WATER TREATMENT DEVICES

1. UV water treatment devices must comply with criteria approved by the reviewing authority or Class A criteria under ANSI/NSF Standard 55 - Ultraviolet Microbiological Water Treatment Systems; each UV water treatment device shall meet the following standards;

a. Ultraviolet radiation at a wavelength of 253.7 nanometers shall be applied at a minimum dose of 40 millijoules per square centimeter (mJ/cm^2) at the failsafe set point at the end of lamp life;

b. The UV device shall be fitted with a light sensor to safely verify that UV light is being delivered into the reactor;

c. The UV light assembly shall be insulated from direct contact with the influent water by a quartz (or high silica glass with similar optical and strength characteristics) lamp jacket to maintain proper operating lamp temperature;

d. The design and installation of the UV reactor shall ensure that the manufacturer's maximum rated flow and pressure cannot be exceeded;

e. The UV assemblies shall be accessible for visual observation, cleaning and replacement of the lamp, lamp jackets and sensor window/lens;

f. A narrow band UV monitoring device shall be provided that is sensitive to germicidal UV light. It shall be accurately calibrated so that it indicates the true irradiance (mJ/cm^2) at 253.7 nanometers and be installed at the location critical for that unit. The device shall trigger an audible alarm in the event the sensor or lamp fails or if insufficient dosage is detected as defined in item ‘a’ above;

g. An automatic shutdown valve shall be installed in the water supply line ahead of the UV treatment system that will be activated whenever the water treatment system loses power or is tripped by a monitoring device when the dosage is below its alarm point of 40 mJ/cm^2. When power is not being supplied to the UV unit the valve shall be in a closed (fail-safe) position.

h. The UV housing shall be stainless steel 304 or 316L;

2. A flow or time delay mechanism wired in series with the well or service pump shall be provided to permit a sufficient time for tube warm-up per manufacturer recommendations before water flows from the unit upon startup. Where there are extended no-flow periods and fixtures are located a short distance downstream of the UV unit, consideration should be given to UV unit shutdown between operating cycles to prevent heat build-up in the water due to the UV lamp:

3. A sufficient number (required number plus one) of parallel UV treatment systems shall be provided to assure a continuous water supply when one unit is out of service;

4. No bypasses shall be installed;

5. All water from the well shall be treated. The well owner may request a variance to treat only that portion of the water supply that is used for potable purposes provided that the daily average and peak water use is determined and signs are posted at all non-potable water supply outlets.

6. The well or booster pump(s) shall have adequate pressure capability to maintain minimum water system pressure after the water treatment devices;

B. PRETREATMENT

The reviewing authority will determine pre and post treatment on a specific case basis depending on raw water quality. See Section G for raw water quality limitations. If coliform bacteria or other microbiological organisms are present in the untreated water, a 5 micron filter shall be provided as minimum pretreatment.

C. PROCESS CONTROL WATER QUALITY MONITORING

Total coliform monitoring and other parameters required by the reviewing authority will be used to evaluate UV treatment effectiveness. The minimum monitoring frequency will be as follows:

(1) Startup and 2 weeks after start up - one raw and one treated sample.

(2) Monthly thereafter - raw and treated.

(3) Monitoring for additional parameters or total coliform on an increased frequency may be required by the reviewing authority.

D. ONLINE MONITORING, REPLACEMENT PARTS

UV light intensity of each installed unit shall be monitored continuously. Treatment units and the water system shall automatically shutdown if the UV dosage falls below the required output of 40 mJ/cm^2. Water systems that have source water exceeding 5 NTU turbidity may be required to install an online turbidimeter ahead of the UV water treatment device. An automatic shutdown valve shall be installed and operated in conjunction with the turbidimeter. Each owner shall have available on site at least one replacement lamp, a 5 micron replacement filter and, where applicable, a replacement cyst reduction filter and any other components necessary to keep the treatment system in service.

E. SEASONAL OPERATIONS

UV water treatment devices that are operated on a seasonal basis shall be inspected and cleaned prior to use at the start of each operating season. The UV water treatment system including the filters shall be disinfected prior to placing the water treatment system back into operation. A procedure for shutting down and starting up the UV treatment system shall be developed for or by each owner based upon manufacturer recommendations and submitted in writing to the review authority.

F. RECORD KEEPING AND ACCESS

A record shall be kept of the water quality test data, dates of lamp replacement and cleaning, a record of when the device was shutdown and the reason for shutdown, and the dates of prefilter replacement.

The reviewing authority shall have access to the UV water treatment system and records.

Water system owners will be required to submit operating reports and required sample results on a monthly or quarterly basis as required by the reviewing authority.

G. RAW WATER QUALITY CHARACTERISTICS

The water supply shall be analyzed for the following water quality parameters and the results shall be included in the UV application. Pretreatment is required for UV installations if the water quality exceeds any of the following maximum limits. When an initial sample exceeds a maximum limit, a check sample shall be taken and analyzed.

Parameter	Maximum
UV 254nm Absorption	20 percent at 1 cm
Dissolved Iron	0.3 mg/L

Dissolved Manganese	0.05 mg/L
Hardness	120 mg/L*
Hydrogen sulfide (if odor is present)	Non-Detectable
Iron Bacteria	None
pH	6.5 to 9.5
Suspended Solids	10 mg/L
Turbidity	1.0 NTU
Total Coliform	1,000/100 ML
E. Coli	**
Cryptosporidium	**
Giardia	**

* A higher hardness may be acceptable to the reviewing authority if experience with similar water quality and reactors shows there are no treatment problems or excessive maintenance required.
** These organisms may indicate that the source is either a surface water or ground water under the direct influence of surface water and may require additional filtration pretreatment. Consult the reviewing authority for guidance.

Raw water quality shall be evaluated and pretreatment equipment shall be designed to handle water quality changes. Variable turbidity caused by rainfall events is of special concern.

Adopted April, 2003

POLICY STATEMENT ON INFRASTRUCTURE SECURITY FOR PUBLIC WATER SUPPLIES

Recent events in the United States and abroad have made it clear that increased security for public water system facilities is imperative. Review of public water systme security infrastructure and practices has shown an industry-wide vulnerability to intentional acts of vandalism, sabotage and terrorism. Protection from these types of threats must be integrated into all design considerations. Many public drinking water systems have implemented effective security and operational changes to help address this vulnerability, but additional efforts are needed.

Security measures are needed to help ensure that public water suppliers attain an effective level of security. Design considerations need to address physical infrastructure security, and facilitate security related operational practices and institutional controls. Because drinking water systems cannot be made immune to all possible attacks, the design needs to address issues of critical asset redundancy, monitoring, response and recovery. All public water supplies need to identify and address security needs in design and construction for new projects and for retrofits of existing drinking water systems.

The following concepts and items should be considered in the design and construction of new water system facilities and improvements to existing water systems:

1. Security shall be an integral part of drinking water system design. Facility layout shall consider critical system assets and the physical needs of security for these assets. Requirements for submitting, identifying and disclosing security features of the design, and the confidentiality of the submission and regulatory review should be discussed with the reviewing authority.

2. The design should identify and evaluate single points of failure that could render a system unable to meet its design basis. Redundancy and enhanced security features should be incorporated into the design to eliminate single points of failure when possible, or to protect them when they cannot reasonably be eliminated.

3. Consideration should be made to ensure effective response and timely replacement of critical components that are damaged or destroyed. Critical components that comprise single points of failure (e.g., high volume pumps) that cannot be eliminated should be identified during design and given special consideration. Design considerations should include component standardization, availability of replacements and key parts, re-procurement lead times, and identification of suppliers and secure retention of component specifications and fabrication drawings. Readily replaceable components should be used whenever possible and provisions should be made for maintaining an inventory of critical parts.

4. Human access should be through controlled locations only. Intrusion deterrence measures (e.g., physical barriers such as fences, window grates and security doors; traffic flow and check-in points; effective lighting; lines of sight; etc.) should be incorporated into the facility design to protect critical assets and security

sensitive areas. Effective intrusion detection should be included in the system design and operation to protect critical assets and security sensitive areas. All cameras and alarms installed for security purposes should include monitors at manned locations.

5. Vehicle access should be through controlled locations only. Physical barriers such as moveable barriers or ramps should be included in designs to keep vehicles away from critical assets and security sensitive areas. It should be impossible for any vehicle to be driven either intentionally or accidentally into or adjacent to finished water storage or critical components without facility involvement. Designated vehicle areas such as parking lots and drives should be separated from critical assets with adequate standoff distances to eliminate impacts to these assets from possible explosions of material in vehicles.

6. Sturdy, weatherproof, locking hardware must be included in the design of access for all tanks, vaults, wells, well houses, pump houses, buildings, power stations, transformers, chemical storage, delivery areas, chemical fill pipes, and similar facilities. Vents and overflows should be hardened through use of baffles or other means to prevent their use for the introduction of contaminants.

7. Computer based control technologies such as SCADA must be secured from unauthorized physical access and potential cyber attacks. Wireless and network based communications should be encrypted as deterrence to hijacking by unauthorized personnel. Vigorous computer access and virus protection protocols should be built into computer control systems. Effective data recovery hardware and operating protocols should be employed and exercised on a regular basis. All automated control systems shall be equipped with manual overrides to provide the option to operate manually. The procedures for manual operation including a regular schedule for exercising and insuring operator's competence with the manual override systems shall be included in facility operation plans.

8. Real time water quality monitoring with continuous recording and alarms should be considered at key locations to provide early warning of possible intentional contamination events.

9. Facilities and procedures for delivery, handling and storage of chemicals should be designed to ensure that chemicals delivered to and used at the facility cannot be intentionally released, introduced or otherwise used to debilitate a water system, its personnel, or the public. Particular attention should be given to potentially harmful

chemicals used in treatment processes (e.g., strong acids and bases, toxic gases and incompatible chemicals) and on maintenance chemicals that may be stored on-site (e.g., fuels, herbicides, paints, solvents).

Adopted April, 2003

INTERIM STANDARD - NITRATE REMOVAL USING SULFATE SELECTIVE ANION EXCHANGE RESIN

Four treatment processes are generally considered acceptable for Nitrate/Nitrite removal. These are anion exchange, reverse osmosis, nanofiltration and electrodialysis. Although these treatment processes, when properly designed and operated will reduce the nitrate/nitrite concentration of the water to acceptable levels, primary consideration shall be given to reducing the nitrate/nitrite levels of the raw water through either obtaining water from an alternate water source or through watershed management. Reverse osmosis nanofiltration or electrodialysis should be investigated when the water has high levels of sulfate or when the chloride content or dissolved solids concentration is of concern.

Most anion exchange resins used for nitrate removal are sulfate selective resins. Although nitrate selective resins are available, these resins typically have a lower total exchange capacity.

SPECIAL CAUTION

If a sulfate selective anion exchange resin is used beyond bed exhaustion, the resin will continue to remove sulfate from the water by exchanging the sulfate for previously removed nitrates resulting in treated water nitrate levels being much higher than raw water levels. Therefore it is extremely important that the system not be operated beyond design limitations.

PRE-TREATMENT REQUIREMENTS

An evaluation shall be made to determine if pretreatment of the water is required if the combination of iron, manganese, and heavy metals exceeds 0.1 milligrams per liter.

DESIGN

Anion exchange units are typically of the pressure type, down flow design. Although a pH spike can typically be observed shortly before bed exhaustion, automatic regeneration based on volume of water treated should be used unless justification for alternate regeneration is submitted to and approved by the reviewing authority. A manual override shall be provided on all automatic controls. A minimum of two units must be provided. The total treatment capacity must be capable of producing the maximum day water demand at a level below the nitrate/nitrite MCL. If a portion of the water is bypassed around the unit and blended with the treated water, the maximum blend ratio allowable must be determined based on the highest anticipated raw water nitrate level. If a bypass is provided, a totaling meter and a proportioning or regulating device or flow regulating valves must be provided on the bypass line.

EXCHANGE CAPACITY

Anion exchange media will remove both nitrates and sulfate from the water being treated. The design capacity for nitrate and sulfate removal expressed as $CaCO_3$ should not exceed 16,000 grains per cubic foot (37 g/l) when the resin is regenerated with 10 pounds of salt per cubic foot (160 g/l) of resin when operating at 2 to 3 gallons per minute per cubic foot (0.27 to 0.4 L/min per litre). However, if high levels of chlorides exist in the raw water, the exchange capacity of the resin should be reduced to account for the chlorides.

FLOW RATES

The treatment flow rate should not exceed 7 to 8 gallons per minute per square foot of bed area (29 to 32 cm/minute down flow rate). The back wash flow rate should be 2 to 3 gallons per minute per square foot of bed area (8 to 12 cm/minute rise rate) with a fast rinse approximately equal to the service flow rate.

FREEBOARD

Adequate freeboard must be provided to accommodate the backwash flow rate of the unit.

MISCELLANEOUS APPURTENANCES

The system shall be designed to include an adequate under drain and supporting gravel system, brine distribution equipment, and cross connection control.

MONITORING

When ever possible, the treated water nitrate/nitrite level should be monitored using continuous monitoring and recording equipment. The continuous monitoring equipment should be equipped with a high nitrate level alarm. If continuous monitoring and recording equipment is not provided, the finished water nitrate/nitrite levels must be determined (using a test kit) no less than daily, preferably just prior to regeneration of the unit.

WASTE DISPOSAL

Generally, waste from the anion exchange unit should be disposed in accordance with Section 9.2 of these Standards. However, prior to any discharge, the reviewing authority must be contacted for wastewater discharge limitations or NPDES requirements.

ADDITIONAL LIMITATIONS

Certain types of anion exchange resins can tolerate no more than 0.05 mg/L free chlorine. When the applied water will contain a chlorine residual, the anion exchange resin must be a type that is not damaged by residual chlorine.

Adopted April, 1997

INTERIM STANDARD - USE OF CHLORAMINE DISINFECTANT FOR PUBLIC WATER SUPPLIES

Ammonia can be used for the conversion of chlorine in drinking water into the longer lasting but less powerful disinfectant chloramine. Possible advantages and disadvantages of the use of chloramine rather than free chlorine include:

Use of chloramine may reduce total trihalomethane concentrations reaching consumers. This is because chloramine does not form trihalomethanes on contact with natural organic matter in the water, although it may form other by-products.

Use of chloramine may reduce the need for high disinfectant concentrations to be added at the plant and/or at booster stations. This can be an advantage during the warmer seasons of the year for protection of the water and mains system from bacterial overgrowth. The lowered disinfectant requirements also can avoid complaints due to some unacceptable chlorine taste/odor problems from consumers located close to water plants, although they may contribute to other problems.

The use of chloramine may provide less protection from contamination of the distribution system through cross connections, water main breaks and other causes.

Unlike most substances added to water for treatment purposes, chloramine cannot be prepared at high concentrations. It can only be made by addition of ammonia to lightly prechlorinated water or of chlorine to water containing low concentrations of ammonia. Contact between high concentrations of chlorine and ammonia or ammonium salts must be avoided because the sensitive and violently explosive substance, nitrogen trichloride, may be formed.

Operating authorities who wish to modify disinfectant practices by using chloramine must show the reviewing authority clear evidence that bacteriological and chemical protection of consumers will not be compromised in any way and that aspects of chloramination mentioned below are considered in any permit application.

1. Chloramine, which is less powerful than free chlorine, may be suitable for disinfection of some ground water supplies but it is inadequate in strength for primary disinfection of surface waters.

2. Chloramine can be suitable for protecting potable water in distribution systems against bacterial contamination. The chloramine tends to remain active for longer periods and at greater distances from the plant than free chlorine. Chloramine concentrations should be maintained higher than for chlorine to avoid nitrifying bacterial activity. A range of 1-2 mg/L, measured as combined chlorine, on entry to the distribution system and greater than 1 mg/L at the system extremities is recommended. Chloramine can be less odorous than chlorine so these concentrations may be tolerated well by consumers.

3. Suitable commercial sources of ammonia for chloramine production are either ammonia gas or water solutions of ammonia or ammonium sulphate. Ammonia gas is supplied as compressed liquid in cylinders which must be stored in separate facilities designed as for chlorine gas. Ammonia solutions must be stored in containment with adequate cooling to prevent gas release from

storage and gas release must be handled with pressure relief systems. Absorption/neutralization systems for ammonia gas leaks/spills must be designed specially for ammonia. Ammonium sulphate is available as free flowing powdered solid which must be stored in cool dry conditions and dissolved in water for use.

4. Thorough and reasonably rapid mixing of chlorine and ammonia in the main plant stream shall be arranged so as to avoid formation of organic chloramines and of odorous dichloramine. Sufficient ammonia must be added to provide at least a small excess (more than one part of ammonia to between 3 and 5 parts of chlorine) over that required to convert all the free chlorine present to chloramine.

5. Addition of ammonia gas or ammonia solution will increase the pH of the water and addition of ammonium sulphate depresses the pH. The actual pH shift may be small in well buffered water but the effects on disinfectant power and corrosiveness of the water may require consideration. Ammonia gas forms alkaline solutions which may cause local plugging by lime deposition. Where hard water is to be treated, a side stream of pre-softened water may be needed for ammonia dilution so as to reduce plugging problems.

6. The use of chloramine in distribution systems which are not well maintained by flushing, swabbing and other regular routine maintenance activities can lead to local loss of disinfectant residual, increased nitrifying bacterial activity and, possibly over a period of time, to persistent high coliform bacterial counts which may not respond to reversion to the use of free chlorine. Early detection of nitrifying bacteria activity may be made by checking for reduced dissolved oxygen, elevated free ammonia, elevated HPC, and elevated nitrite and nitrate levels.

7. Chloramine in water is considerably more toxic to fish and other aquatic organisms than free chlorine. Consideration must therefore be given to the potential for leaks to contaminate and damage natural water course eco-systems. Kidney dialysis treatment can be upset by use of chloraminated water. Medical authorities, hospitals and commercial and domestic aquarium keepers should be notified so they can arrange for precautions to be taken.

Policy Statement Adopted April, 1997
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